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DROWSINESS DETECTION AND ACCIDENT AVOIDANCE SYSTEM IN VEHICLES

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ABSTRACT

Driver drowsiness is one of the major causes of road accidents and it can lead to serious physical injuries, loss of human life, damage to property & loss of money. So a reliable driver drowsiness detection system is needed to be implemented, which would alert the driver before anything undesired happens. In this paper, design and implementation of 'Driver Drowsiness Detection System with Audio-Visual Warning' will be discussed. This system is to be evolved for car driver, but the scope of this system is far more than it. It can be used in any situation where a person's drowsiness is needed to be monitored. The planned system can use a camera that takes pictures of driver's face and monitors the driver's eyes in order to detect drowsiness of driver.

Once fatigue is detected, the alarm will be used to alert the driver. The proposed system will work in 3 main stages, in 1st stage the face of the driver is detected and tracked. In the 2nd stage the facial features are extracted for further processing. In last stage, eye's status is monitored. In 3rd stage it is determined that whether the eyes are closed or open. On the basis of this result the warning is issued to the driver. For this Raspberry pi with raspbian (Linux) OS is used. The camera will be connected through USB port of Raspberry pi. The picture processing will be done using OpenCV.

***KEYWORDS:** Advanced Vehicle Safety, Driver Drowsiness Detection, Driver Fatigue, Raspberry-pi, Raspbian, VehicleAccident Warning*

INTRODUCTION

Drowsiness will be a process in which one level of awareness is reduced because of lacking of sleep or fatigue and it can cause the driver constitute sleep quietly. Once the driver is affected by drowsiness driver loses the control of the car thus driver could be suddenly deviated from the road and hit an obstacle or a car to overturn. According to available statistical data, over 1.3 million people die annually on the road and twenty to fifty million people suffer non fatal injuries because of road accidents [1]. Based on police reports, the U.S. National Highway Traffic Safety Administration (NHTSA) cautiously estimated that an entire of 100,000 vehicle crashes annually are the direct result of driver drowsiness. These crashes resulted in approximately 1,550 deaths, 71,000 injuries and $12.5 billion in monetary

losses. In the year 2009, the U.S. National Sleep Foundation (NSF) according that 54% of adult drivers have driven a vehicle while feeling drowsy and 28% of them actually fell asleep. There are 2 strategies for drowsiness detection. The first one is intrusive strategies and also the other is non-intrusive methods. The intrusive strategies include measurement of heartbeat rate, mind wave observation etc. It is most accurate, however it is not realistic, because sensing electrodes should have to be connected directly onto the user's body, and thus it might be annoying and distracting the user. While the non-intrusive strategies include the yawn detection, eye closure, eye blinking rate, head pose etc… [2]. It is realistic because it doesn't irritate the user while driving because no sensing electrodes would be connected to user's body. Specific system uses raspberry pi which is small in size, less power requirement and has low price compare to other computers like desktop and laptop computer solves some issues of existing systems. Face and eye detection is done using Haar cascade classifier. Open CV is used to increase efficiency.

BACKGROUND

The Raspberry Pi is a basic embedded system having a credit card-sized single board computers developed in the UK by the Raspberry Pi Foundation. It is supported on ARM processor, which is used in most smart phones and tablets. The raspberry pi is intended to be used as headless (Just a CPU), but is widely used with totally different Displays, Touchscreens and multimedia system components. This planned system uses raspberry pi 2 model B, which is latest at this time. The physical view of raspberry pi 2B is as shown in figure 1. The raspberry Pi board is likely just a CPU which has all necessary components on board for processing. The components on board are as shown in figure 1. It has 1 GB RAM, 40 GPIO for connecting inputs/outputs. The CPU is Quad core BCM2836, that runs at 900MHz frequency [3]. The processor is based on ARM v7 design.

Raspberry-Pi	A	A+	B	B+	Pi 2B
RAM	256 Mb	256 Mb	512 Mb	512 Mb	1 Gb
Processor Cores	Single	Single	Single	Single	Quad
Processor Speed	700 Mhz	700 Mhz	700 Mhz	700 Mhz	900 Mhz
Voltage and Power	300ma,5v	200ma,5v	700ma,5v	600ma, 5v	650ma@5v

FIGURE 1: RASPBERRY PI 2B [2]

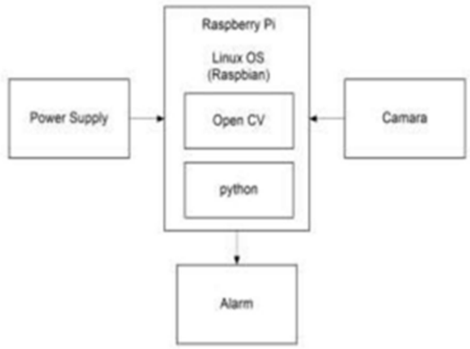

FIGURE 2: BLOCK DIAGRAM OF PLANNED SYSTEM

PROPOSED METHODOLOGY

OVERVIEW OF THE PLANNED WORK

There are many signs by which we can detect the drowsiness of drivers. They are as given below:

- Driver may be yawn frequently.
- Driver is unable to keep eyes open.
- Driver catches him nodding off and has trouble keeping head up.

Driver drowsiness detection system is a system that's implemented using picture processing to detect drowsiness of the driver. This application are offen terribly helpful to reduce the accidents, because most accidents happens because of drowsiness of drivers. With use of this application the driver's status can be monitored, like yawning, fatigue, closure of eyes etc. The status of driver's face is continuously monitored using the camera. The alarm would be used to give an alert, if any sign of drowsiness is detected.

The planned system can work in 3 main stages:

1. In 1st stage the face of the driver is detected and tracked.
2. In the 2nd stage the facial expressions are extracted for further processing.
3. In last stage, eye's status is monitored. During this last stage it is determined that whether the eyes are closed or open. On the idea of this result the warning is issued to the driver.

For this system I'm going to use Raspberr Pi with raspbian (linux) OS. The camera will be connected through USB port of raspberry pi. The picture processing will be done using OpenCV.

FLOW CHART OF PLANNED SYSTEM

The flowchart of picture processing part is shown as fig. 3. The camera is connected on Raspberry Pi using USB port. The camera needs to be initialized at the start-up of code. The modules of camera will be loaded and it can ready to take pictures. The captured pictures are processed to detect face of the driver. If the face is not detected in the processed picture, it will continue to capture picture and process it. If the face is detected in- the frame, it will be processed to extract facial expressions. The picture will be process to detect open eyes. If the eyes are open, the code will continue to capture & process picture. If the eyes are closed, the system will check first, if the timer is ON or OFF. If the timer is OFF, it will be turned ON. And if it is ON, it'll check if the time is greater than two seconds. It time is less than 2 seconds, it will return and continue to capture and process picture. If the timer exceeds time of two seconds, the alarm will be turned ON. The alarm will be played using GPIO port of Raspberry Pi [4]. One pin will be initialized as Output and hardware alarm will be connected on that. Pin will be set ON to turn on the alarm.

After turning ON the alarm, the General Purpose Input Output module of raspberry Pi will be initialized to

require input from user. One button will be connected on GPIO module to take input. The alarm can stopped if the button is pressed. By this mechanism the driver can turn the alarm off when he/she is awakening, and additionally the system will be return to capture and process the pictures. Flow chart shown in figure 3.

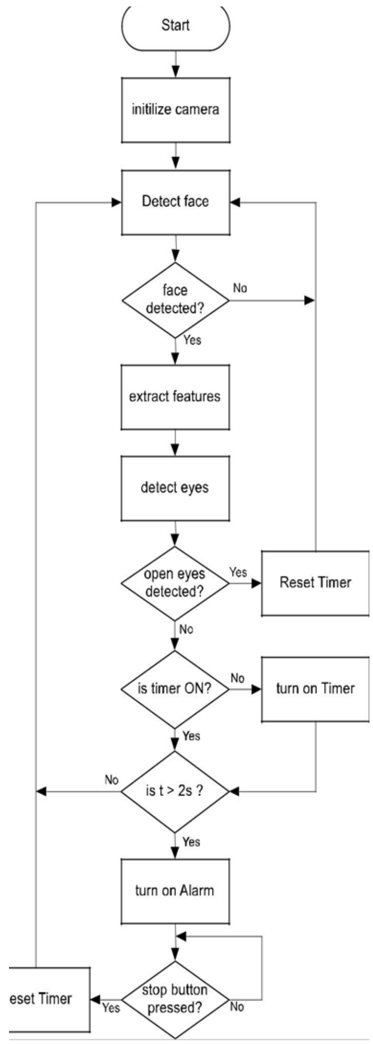

FIGURE 3: FLOWCHART OF PLANNED SYSTEM

PERFORMANCE EVALUATION

Speed :

The speed of system is outlined as the frequency of total program instructions for one explicit cycles. Higher the frequency, better the performance.

Speed =cycles per second

Speed =1/Tm

Where, Tm is time taken by one complete cycle of total program instructions.

Accuracy :

The accuracy is defined by the ratio of correctly detected eye state, by the overall samples taken by camera. One particular cycle can be explained as one sample.

Accuracy = Nc/Nt

Where Nc = number of samples in each and every states

Nt= total number of taken samples

Speed = cycles per second

Speed = 1 / Tm

Speed = cycles per second

Speed = 1 / T

WORK RESULTS

FACE AND EYE DETECTION IN PICTURE

Following figs. 4(a) & 4(b) shows the detected face and eye from the picture. The face and eye detection is done using Haar Cascade Classifier technique. The blue square will be drawn in result picture automatically when the execution of python code.

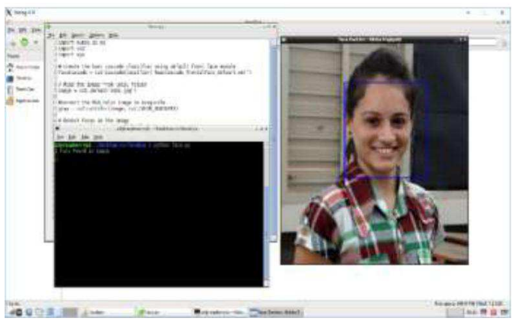

FIGURE 4: (A) DETECTED FACE PICTURE

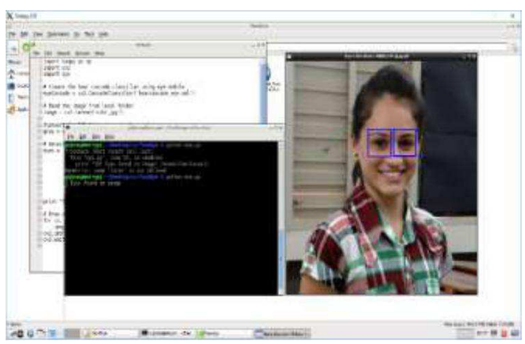

FIGURE 4(B): DETECTED EYES IN THE PICTURE

MOUTH AND NOSE DETECTION IN PICTURE

Mouth and Nose detection is shown in figs 5(a) & 5(b). The aim of mouth detection is to detect yawning if possible for future scope. In the result of nose detection, the nose is detected in face region correctly, but it is also detected in background, which is an error. So we can remove this error by limiting the picture search area. First the face will be detected, and from that area of face, the other features like eyes, nose & mouth will be detected. This can solve the problem.

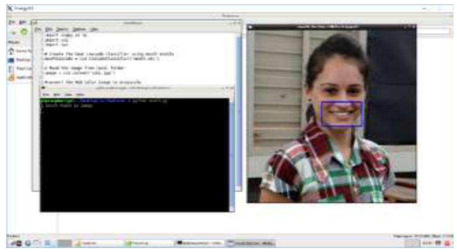

FIGURE 5(A): DETECTED MOUTH IN A PICTURE

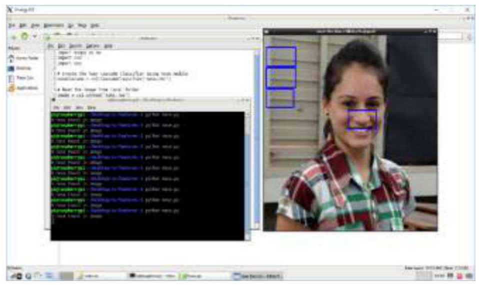

FIGURE 5(B): DETECTED NOSE IN AN PICTURE

FACE, EYE & MOUTH DETECTION IN PICTURE

In the figure 6, the detection of Face, Eye & mouth is shown. It's implemented using the strategy explained in previous section [5]. The result is better and accurate this way, because it reduces the possibility of error by limiting the search area to only face region.

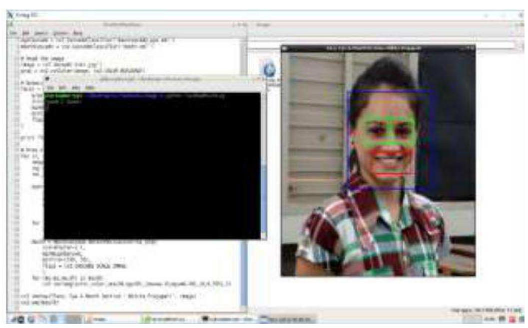

FIGURE 6: DETECTED FACE, EYES & MOUTH IN AN PICTURE

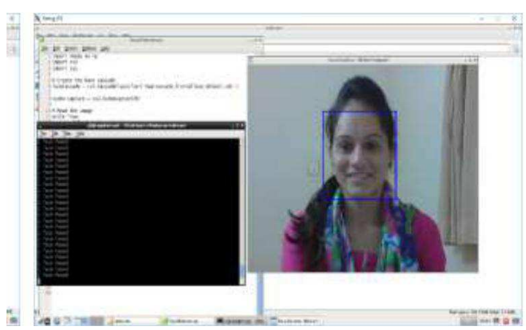

FIGURE 7: DETECTED FACE THROUGH WEBCAM

FACE DETECTION USING LIVE WEBCAM

The detection of face is done using live webcam as shown in fig. 7. During this code, the USB webcam is designed for taking pictures and that picture is taken for processing using same methodology as above Face detection is accurate using Haar cascade technique compare to other like LBP.

Face, Eye, Mouth & Nose Detection using Live Webcam

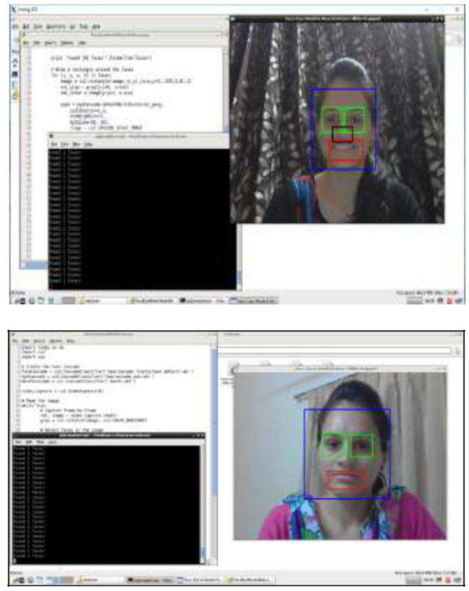

Figure 6: Detected Face, Eyes, Mouth and Nose through Webcam

In the figure above, the detection of Face, Eye, Mouth and Nose using live webcam is shown. It is also using the same methodology. This also works in low lighting condition as shown in figure. All the results are accurate for various users.

Open and Closed Eye Detection

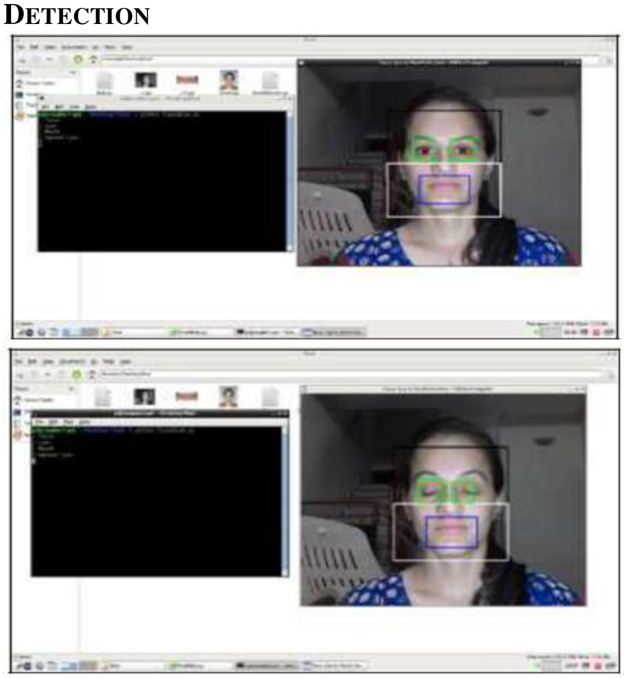

Figure 7: Detected Open and Closed Eyes

The eye status monitoring is done using Blob detection. Figure shows the detected open and closed eyes. It draws circles around eye region as shown in figure. For face and eye detection is done using Haar cascade methods. Only eye status monitoring is done using blob detection to check eye status whether it closed or opened. Also it is accurate.

SETUP OF SYSTEM

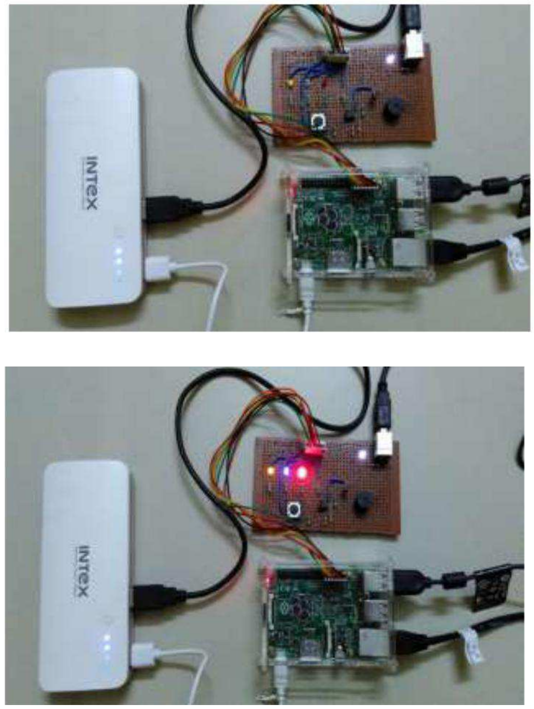

FIGURE 8: EXPERIMENTAL SETUP OF RUNNING SYSTEM

The complete hardware configuration is as shown in above figure. There are total 4 LED, White, Yellow, Blue, Red are used as shown in above figure. White for power supply. Yellow LED will be on when system start running. Blue LED for face detection. If face is detected, then it will be turned on otherwise it will remain off. Red LED is used for eye status monitoring. When close eye is detected red LED will be turned on [6]&[7]. If closed eye detected the Red LED will be turned off. There is also one switch to stop buzzer.

RESULT ANALYSIS

The accuracy of frontal face and the eyes detection is as shown in figure 14. Face and eye detection is tested using Haar cascade algorithm and Local Binary Pattern (LBP) [8]. In graph, we will see that the accuracy of both face and eye detection is high using Haar cascade classifier algorithmic rule as compare to the local binary pattern. Accuracy of frontal face using Haar cascade and lbp are around 100% and 92% respectively.

And the accuracy of eye detection using Haar cascade and lbp are around 100% and 79% respectively as shown in following figure.

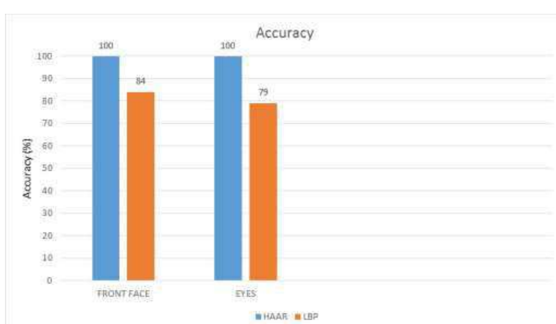

FIGURE 9: ACCURACY OF FACE AND EYES DETECTION

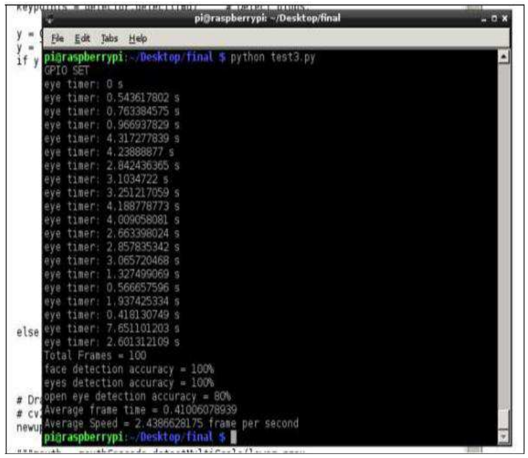

FIGURE 10: ACCURACY AND SPEED

CONCLUSIONS

There are several intrusive and non-intrusive methods to implement driver drowsiness detection system. From the study and design of planned work it's clear that usage of raspberry pi and opencv is even a lot of appropriate for this specific application in terms of size, cost and power requirement The results are accurate and reliable for detection of face, eyes & mouth. The operations are performed on static picture as well on feed of live webcam. It is observed that, the result varies due to un-even lighting conditions; however it is accurate even in low light conditions. Specific system will be used in real working environment. In future yawning detection and head nodding will be possible.

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